EXTRUSION-BASED BIOPRINTING IN MUSCULOSKELETAL TISSUE ENGINEERING

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3D bioprinting has the potential to fabricate highly customizable and highly organized structures that, in principle, could be used for the assembly of entire engineered human organs. This emerging biofabrication technology relies on the simultaneous deposition of cells and biomaterials in a layer-by-layer fashion, to form 3D well-organized heterogeneous structures that can mirror relevant complex biological architectures both physiologically and morphologically. Thanks to these attractive features, 3D bioprinting is rapidly becoming a first-choice technique for a broad set of tissue engineering (TE) scenarios, including musculoskeletal tissue engineering.

Recently, we have developed an innovative deposition system based on a coaxial-nozzle printing head (Figure 1). This method relies on the property of solutions containing ALG to undergo an instantaneous gelation when exposed to divalent calcium ions. The internal nozzle of the dispensing system is fed with a bioink containing ALG and photocurable biopolymers (such as GelMA, HA-MA, CS-MA, PEG-fibrinogen-MA etc.) while the external one is supplied with a solution of calcium chloride. When the two flows come into contact at the tip of the inner nozzle, the bioink undergoes instantaneous gelation and hydrogel fibers can be precisely laid down with high resolution (~ 100 □m) in 3D.

By formulating tailored bioink and precisely controlling the 3D spatial organization of the extruded hydrogel fibers, 3D bioprinting has been tested for the fabrication of advanced engineered constructs for the regeneration of musculoskeletal tissues [1], [2].

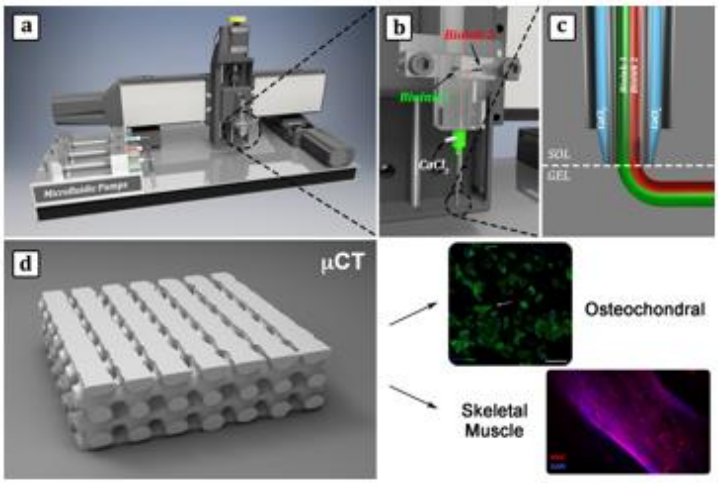

Figure 1 – 3D bioprinting set-up. a) 3D printer equipped with fully programmable microfluidic pumps. b) Microfluidic printing head coupled to (c) coaxial extruder. d) X-ray μCT scan of a 3D printed sample.

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